PATENT SPECIFICATION

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International Classification:—F 07 f.

COMPLETE SPECIFICATION

DRAWINGS ATTACHED

Explosive Charge and Process for the Production thereof

We, THE DOW CHEMICAL COMPANY, a Corporation organised and existing under the Laws of the State of Delaware, United States of America, of Midland, County of Midland, State of Michigan, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly descrbed in and by the following statement:—

The present invention relates to an improved explosive charge, to a process for the production of the novel charges and to a new method of blasting.

Many attempts have been made to improve the blasting effect and power factor of explosive charges used in mining and similar operations. The various proposals included such measures as enclosing the explosive charge in cartridges or heavy cases of various kinds made from metals, including aluminium and aluminium alloys. Other attempts of improving the blasting techniques have been directed toward means and measures for directing the blasting effect. Generally, this work was guided by the principle of mechanically or physically confining or directing the force developed by the detonation with the hope of concentrating the effect so that the maximum amount of work could be obtained from the explosive at the location and in the direction which was most desired for the specific application.

In spite of all these efforts, present day explosive charges, as they are used in the mining industry and similar operations, are still amenable to improvement. This applies particularly to the possibility of upgrading the power factor or the ratio of inherent, usable energy converted into useful work. As is well known, generally the initial thermal heats of reaction are not effectively utilized with conventional explosive systems. The present invention makes an important contribution toward this end by devising novel charges and methods which permit, for the first time, an unexpected high degree of upgrading of the power factor of the explosive.

This is accomplished in accordance with the present invention by confining or impeding momentarily the outward flow of energy in the initial detonation wave front, not by structural confinement but by means hereinafter defined. The energy is thus retained within the explosion reaction zone for sufficient time to permit its utilization by the epxlosive charge and thus its conversion into work.

According to the invention, there is provided an improved eplosive charge comprising a cavernous structure of coarse, individual components of an electron-conducting material distributed throughout the charge in such a manner that the components are substantially in electrical contact throughout, a substantial proportion of the components being of such size that they are retained by a 20-mesh U.S. Standard seive and of such an irregular shape that they form a system of cavities and channels which contain the eplosive material. The coarse components of the electron-conducting material, when contained in a borehole or other confining surrounding, form, even in the absence of the explosive, a self-supporting structure of definite shape *e.g.* cylindrical. The explosive material is distributed and contained in the interstices or spaces of the structure so that the charge is, in effect, composed of an interconnected system of explosive, contained within a structure of continuous electron-conducting material. The term "cavernous" as used herein is meant to express the characteristic

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that a number of cavities, cells, or interstices of any desired shape are present within the structure.

The electron-conducting materials is generally a metal and, preferably one having a relatively high conductivity. Further advantages are realized if the metal is of a kind which is readily oxidized with the formation of high amounts of heat energy thus contributing to the end of producing useful work. This prerequisite is ideally fulfilled by the light metals, such as magnesium or aluminium or their alloys. It is to be noted that the function of the metal as an oxygen acceptor is only secondary and not mandatory. The function of the structure of the electron-conducting material is in no way identical or even comparable to that of the finely powdered metals, and particularly light metals, which have been added to explosives in order to improve their performance. The effects and improvement produced by the present invention go much beyond the level of improvements which can be achieved by the admixture to the oxidizing explosives of the particulate metals alone.

In one modification of the explosive charge the cavernous structure of the electron-conducting material is made up of course, irregularly shaped, individual components or elements, having a smallest dimension, with advantage, of at least 1 millimeter and, preferably, up to 6 mm. or more. The length of these components or elements may be up to 10 or 15 cm. or more. Independently thereof, a substantial proportion of the components or elements should be large enough to be retained by a 20 mesh sieve (8 meshes per linear centimetre) in order to produce the benefits of the present invention. The objectives of the invention are most readily achieved if the irregularly shaped components or particles of the electron-conducting materials are elongated, *i.e.*, if one dimension is substantially smaller than the others. Among the multitude of conceivable shapes, circular, angular, curved, curled and/or rolled configurations are preferred. Regardless of the shape and size of the individual particles or components making up the cavernous structure, it is desirable that as large as possible an area is available for direct contact of individual components or particles of electron-conducting material within the structure. Since the conducting metal is distributed substantially throughout the explosive in a manner such that the metal particles are in electrical contact throughout, an electrical charge will be substantially immediately distributed throughout the explosive.

The inventive concept underlying the explosive charges of the present invention can be applied with great benefit to any desired explosive. However, it was found that the most striking improvements have been achieved with those charges which consist of or contain as a constituent, ammonium nitrate. Explosive charges of this kind and type may be readily produced by the insertion of the irregularly shaped components or particles of the electron-conducting material into a borehole or container and filling the interstices left within the cavernous structure thus obtained with the explosive, which may be introduced, for instance, in the form of a liquid or slurry. In the case of ammonium nitrate explosive, the liquid is preferably an aqueous, ammoniacal or an aqueous ammoniacal solution and/or a dispersion of the ammonium nitrate.

It was found to be particularly beneficial if at least part of the electron-conducting material had a generally circular or curvilinear configuration. This applies particularly, also, to the tamps which may be employed in combination with the charge of the present invention. The tamps may be of such material that they do not exert their effect by mere mechanical or structural strength and are, preferably, composed of one or more individual plates or similar structures. If possible, at least one of the plates or surfaces of the tamps should be in direct contact with the explosive and/or the electron-conducting material forming the cavernous structure in order to produce the highest possible directional effects in the charge. Further, the tamp should be located at a position with respect to the explosive so that it will have the desired directing effect. The plate or plates making up the tamps need not be of heavy construction, and it is not required that they have the structural strength to divert the blast by air by their mechanical strength. They may, therefore, be made from relatively thin materials. Those prepared from good conductors, of electrons and especially from light metals, are preferred. The plate or plates or other elements making up the tamp may be perforated.

As is apparent from the foregoing, the novel charge and method of the present invention significantly upgrades the power factor of explosive systems generally. In its most preferred embodiment, this involves the placing of an energy-absorbing and electron-conducting material in the reaction zone of the explosive charge, such energy-absorbing and electron-conducting material, preferably metal, having a sufficiently coarse particle size and such an irregular shape so as to be capable of support in spaced relationship, when placed in the borehole with the charge. Generally, metal conductors having curvilinear or curved surfaces and

possessing sufficient mass or body to produce strong electrical surge currents within themselves upon the passage of electrons are preferred. When the electron-conducting or energy-absorbing material is placed directly in homogeneous admixture with the explosive composition or charge, we have called the resulting phenomenon "inner circuitry," as shown in the inset of Figure 1 of the accompanying drawing. By employing these methods, novel explosive compositions also have been produced, exhibiting enhanced power factors upon full detonation.

Referring to the accompanying drawings:

Figure 1 is a schematic cross section elevational view of a borehole illustrating the reaction zone with an electromagnetic tamp (discussed hereinafter) positioned at the top of the reaction zone, with the zone also containing the explosive material in admixture with particles of metal, an enlarged inset magnifying the random orientation of the metal particles, i.e., energy-absorbing material, in spaced relationship with the explosive material within the reaction zone.

Figure 2 is a cross section elevational view of a metal tube into which has been placed discrete particles of metal packed only sufficiently to avoid dislodgment and having interstices between the metal particles for receiving the eplosive material for borehole loading, the tube establishing an external electron-conducting circuit and the metal particles providing electron energy-absorbing material in spaced relationship (inner circuitry) in the ultimate explosive material.

Figure 3 is an elevation view of a metal canister having perforations therein and for containing particles of electron energy-absorbing material in spaced relationship and having internal baffle supports.

Figure 4 is a cross section elevational view of the canister of Figure 3 taken on the line IV-IV with baffle and contents removed.

Figure 5 is a cross section plan view of the canister of Figure 3 taken on the line V-V with baffle in position, but with contents removed.

Figure 6 is a cross section plan view of the canister of Figure 4 taken on the line VI-VI with baffle and contents removed and indicating the perforation of the end closure.

Figure 7 is a perspective view of an expanded metal baffle (inner circuitry) spirally wound for insertion in the canister of Figure 3.

Figure 8 is a full cross section elevational view of the filled canister of Figure 3 showing the foil baffle (electron energy-absorbing material) in position and the electron energy-absorbing metal material in loosely packed relationship in the canister, a partial enlarged view thereof being indicated in the reference inset.

Figure 9 is a perspective view of a plurality of interconnected spaced apart electro-magnetic perforated tamp elements for positioning above a shot load in a borehole and indicating the plurality of spaced connectors therebetween.

Figure 10 is a partial perspective view of a modified sheet metal tamp prepared by the folding of foil, for example, as shown wherein one set of folds is parallel and spaced apart and a second series of plural parallel folds is transverse to the first folds, thus providing variant metal thicknesses throughout the tamp surface.

The novel charges and processes of the present invention have found applicability to a wide variety of organic and inorganic explosives, including solid, granular, slurried, wetted, liquid and gaseous systems. Included, for example, are nitroglycerine, trinitrotoluene, conventional plasticized explosives, and the like. Preferred explosives include, for example, the stable oxidizing salts, such as the nitrates, nitrites perchlorates, sulphates, chlorates, chromates, and many other salts capable of liberating oxygen upon detonation and peroxides. Especially useful are ammonium nitrate explosives, in granular, slurried, wetted or solution form.

The preferred metal conductors useful in the present invention are light metals, such as those found in the low atomic weight poistions of groups I, II and III of the periodic classification of the elements. These include preferably magnesium, aluminium, magnesium alloys, aluminium alloys and aluminium-magnesium alloys. Other operative metals are iron, zinc, calcium, lithium, sodium, strontium, barium, beryllium, titanium, some rare earth metals, and many alloys of these metals.

Advantageously, each individual component or element of metal conductor has curved or curvilinear surfaces, as in the shape of tubes, rolls, cylinders, curley chips and shavings, wires, perforated discs and the like, as illustrated in the inset of Figure 1. Also operative are chopped scraps and strands, machinings, band saw filling, millings, foils, bars, sponges, routings and wools. The configuration is such that the energy-absorbing material will be substantially self-spacing when placed in the borehole or other situs of the explosive charge. These forms may be up to 6 mm or more thick and 10 to 15 cm or more in length. Expanded foil baffles, as shown in Figure 7, also contribute circuitry to the system. Too finely particulated metals do not permit, by their geometry, the establishment of contact between the individual particles and at the

same time leave sufficiently big interstices to form the system of channels and cavities for the explosive. The coarser components or elements used in the present invention do not have the disadvantages of the finely particulated metals which sometimes are too sensitive and thus hazardous. Furthermore, they remain principally in the metallic state even though their surface may be oxidized, as may be the case with light metals such as aluminium, and magnesium if they are employed in to finely particulated form.

Additional enhancement of the power factor and efficiency of the explosive charge of the present invention may often be achieved if the charge is surrounded by or contained in a sheath of a conductor which likewise is advantageously a metal, preferably a light metal. The outer sheath may have a curved or curvilinear surface, and may have the form of a cylinder, canister, tube, and the like which may be in embossed or lattice-like form. These conductors are essentially containers placed in the reaction zone yet which effectively surround or jacket the explosive charges, as shown in Figures 2, 3, 4, 5, 6 and 8. These containers or sheaths are even effective in impeding the surge of energy when formed from thin foils and when they are perforated or open mesh and expanded metal jackets.

It was found that the operation of the explosive charges of the present invention may be further improved by providing one of more tamps. A well-designed tamp effects a substantial reduction of the tendency to "rifling" i.e. the expulsion of earth and the like from the borehole. Tamps made of nonconductive materials were ineffective but those made of conducting materials did achieve significant tamping effect. In general in like design structures the better the conducting qualities were the better the tamping effect achieved. Structures that were most effective were ones having multiple closed electrical circuits in both horizontal and vertical planes and with enough surfaces to impede energy flow by reflection, refraction and absorption.

These metal shields may be considered as electromagnetic or inductive tamps as illustrated in Figures 9 and 10. Preferably, they are composed of several layers of expanded metal material so devised that both reflecting surfaces and plural overlays of closed electrical circuits in both vertical and horizontal planes are included. These are placed at the top or upper periphery of the reaction zone of the explosive charge.

Generally, the electro-magnet or inductive tamps may be made from a large variety of metals. These metals include iron, lead, tin, nickel, manganese, chrmium, magnesium, aluminium and the like. The heavy metals tend to choke off or drive down into the ground the initial reaction forces whereas magnesium and aluminium not only do this but also tend to enter into the system as reactants and may eventually be vaporized.

In the past "rifling" of holes has been controlled by using a long column of drill cuttings to stem (tamp) the hole above the charge. This tendency of shots to "rifle" is now being controlled by the tamping device. This allows loading a higher column of powder in the hole and still controls the "rifling." In practice, the effectiveness of these novel tamps has permitted boreholes to be loaded and tamped with only about 2.5 m of drill cuttings or other tamp material whereas under ordinary circumstances the same load required about 7 m of tamping in order to prevent "rifling" of the explosive charge.

In test shots it has been demonstrated that the inductive tamping device tends to direct the explosive forces outward and downward, i.e., in tests in sand extreme heat was found up to a metre or more below the level of the load where the tamping device was used. In comparative tests using conventional explosives, the heat penetration downward was not discernable for more than about 5 to 10 cm or so.

Observation of shots wherein the above-described features of the invention, including the electro-magnetic tamp, were employed in the reaction zone of the explosive mass indicated a strong confinement and use of the electrical and thermal energy attending the explosion to the situs of the blast with less indication of energy loss to the surrounding rock and upward through the borehole. Substantial elimination of "rifling" is observed and an actual tendency in open pit blasting to concentrate the explosive energy in the useful work of breaking rock is achieved.

While the composition and processes of the present invention have been described fully in their application to oil well and mining operations, as for example in quarrying, construction and in porous rock blasting, these processes and compositions may have applicability as solid fuels for many purposes.

The theoretical background underlying the present invention is not fully understood. A possible explanation is that the positioning of an electron-conducting and energy-absorbing material, preferably a light metal, in various ways within the reaction zone provides a substantial impeding effect to the movement of the free electrons emanating from the detonation wave front. In effect, electron "traps" are provided that readily receive the moving electron front, absorbing the heats of both the impact and of the strong electrical surge

currents that are set up within the metal. The multiple impacts and the strong electrical surges cause large quantities of heat to be generated, readily raising the temperature of the metal. The heated metal may then undergo reaction with oxygen, nitrogen or other materials with the concomitant liberation of tremendous quantities of heat. This great effect, characteristically observed in all explosion systems where circuitry has been employed, together with the expansion of the end-products may be largely responsible for the unusually high power factors obtained with the explosive compositions of this invention.

It also appears that the free electrons impart to the energy-absorbing metal the electro-magnetic energy they are carrying. This energy adds to the electrical surge being generated within the metal by the moving electrons and thus contributes to the heating of the metal.

It further appears that at least a portion of the initial thermal heats of reaction also being carried in the initial detonation wave by the free electrons, is imparted to the metal, thereby contributing thermally to the eventual vaporization of the metal. It is possible that other portions of the initial heats of reaction are utilized in rapidly raising the temperature of the explosive material, e.g., an oxidizing salt, positioned immediately ahead of the shock front, especially with those heats or thermal energies being carried by the electrons that are reflected or refracted on the surface of the metal. In other respects, the reflection and refraction of the electrons, shock waves, or light waves carrying these thermal energies, may be viewed simply as a means of momentarily confining or impeding the outward progress of the energy so as to permit the thermal energies or heats as well as the electrical energies to be held in the reaction zone for sufficient time to materially raise the temperature of the explosive composition, including the oxidizing salt, for example.

As a consequence of the alteration of the nomal path of the electronic front by the interpositioning of the generally curvilinear energy absorbing materials in the reaction zone, the course of the detonation wave or shock front is also altered, as discussed above. The shock wave then tends to follow the contours of the conducting metals so interposed and islikewise impeded in its progress. There is some evidence that such interposed and is likewise impeded in its progress so that the major shock waves emanating from the full detonation in the reaction zone catch up with the initial shock wave, which then function to amplify the major shock waves, resulting subsequently in greater movement of the burden.

While one possible theoretical basis of the enhanced power factors observed with the compositions of this invention is discussed above, other explanations may be considered. For example, the extremely high heats observed may cause the gaseous materials to be raised to the plasma state, i.e., the state at which they no longer respond to the ordinary gas laws. Thus, the confining or impeding of the electrons may produce a plasma of ions and free electrons upon which subsequent recombination produce a tremendous shock, thereby enhancing the power of the explosives.

As is apparent from the following examples, finely divided light metals may be used in combination with the cavernous structure of the present invention without detracting from its effectiveness in improving the power factor of the explosive charge of the present invention.

EXAMPLE 1:

A 2.5 kg explosive composition comprising (a) 72 percent by weight of a liquid ammoniacal ammonium nitrate solution, formed from 69.8 parts ammonium nitrate, 23.8 parts liquid ammonia and 6.4 parts water, (b) 14 percent by weight of coarse magnesium machine chips, and (c) 14 percent by weight of coarse aluminium machine chips were prepared and placed in a flexible polyethylene bag. The test load was then placed in a 1.8 m deep borehole in the ground in the test area and tamped with 1.35 m of sand. The test load was permitted to stand one hour and then was fired electrically using a shaped charge (Munroe Jet). The load was successfully detonated.

The blast produced a crater 2.85 m in diameter in the test area.

When the same amount of finely particulated metal was used in a similar charge and tested as above, which metal particles were of a size such that a cavernous structure was not present (i.e. the metal particles were not self-spacing), craters of considerably smaller diameters resulted.

EXAMPLE 2:

Following the procedure of Example 1, an identical composition was prepared and placed in a corrugated aluminium container 15 cm in diameter and 17.5 cm in height, illustrated in Figure 4, instead of being placed in the polyethylene bag. The test load was fired successfully.

An excellent blast occurred and produced a crater 3.30 m in diameter in the test area.

EXAMPLE 3:

In the manner of Example 1, an explosive composition comprising (a) 1.6 kg of a liquid ammoniacal ammonium nitrate solution formed from 69.8 parts ammonium nitrate, 23.8 parts liquid amonia, and 6.4 parts water, (b) coarse magnesium chips and

rotary fillings and (c) 0.45 kg coarse aluminium machine chips was formed and placed in a polyethylene bag. The test load was placed in the borehole, tamped, aged, and fired successfully in the manner of Example 1.

The blast produced a crater 3 m in diameter and 1.05 m deep.

EXAMPLE 4:

Following the procedure of Example 3, an identical test load was prepared in which magnesium tubular straw-like curls were substituted for the magnesium coarse chips and rotary filings and then placed in a flexible polyethylene bag. The test load was placed in the borehole, tamped, aged and fired successfully.

The blast produced a crater 3.6 m in diameter and 1.5 m deep.

EXAMPLE 5:

An explosive composition was prepared from 1.8 kg of the liquid ammoniacal ammonium nitrate solution of Example 1, 0.34 kg of coarse aluminium chips and turnings and 0.34 kg coarse magnesium curled chips. The composition was placed in a foil canister, formed by taking two laps of foil, of the type shown in Figure 7, shaped into a cylinder and having the bottom tucked in. The test load was placed in a 1.8 m deep borehole and permitted to age at ambient conditions. The load was observed to undergo auto-reaction, evidenced by liberation of heat, and within 2-3/4 hours a solid, granular reaction product was formed. Two days later the solid explosive product was tamped with 1.2 m of sand and fired eelctrically using a shaped charge. The load was successfully detonated.

The blast produced a crater 3 m in diameter and about 1.2 to 1.6 m deep.

EXAMPLE 6:

The initial metal loaded solution composition of Example 5 was prepared and placed directly in the borehole without being enclosed in the outer foil canister. The load solidified into a granular reaction product within 2 3/4 hours. Two days later the solid explosive was detonated successfully in the manner of Eample 5.

The blast produced a crater 2.25 m in diameter and not as deep as that of Example 5.

EXAMPLE 7:

The initial metal loaded composition of Example 5 was prepared and 6 percent of its weight of water added. The resulting composition was placed in the foil canister of Example 5 and loaded into the borehole. It solidified in 2 hours and two days later was detonated successfully.

The blast produced results of the same order as Example 5.

EXAMPLE 8:

In taconite deposits, standard boreholes were loaded with 500 lk loads of conventional ammonium nitrate explosives (fertilizer grade ammonium nitrate prills wetted with fuel oil). 7 m of rock rubble were used as a tamp in order to prevent "rifling" of the explosive charge from the borehole.

Utilizing the three-platter iron electromagentic tamp, as illustrated in Figure 9, 2.4 m of rock rubble tamp permitted the load to be fired successfully without "rifling."

EXAMPLE 9:

Following the method of Example 5, an explosive composition was prepared from 1.8 kg of the liquid ammoniacal ammonium nitrate solution of Example 1, 0.34 kg of coarse aluminium machinings and 0.34 kg of magnesium ribbons (in flaky form above 1.25 cm wide by 20 to 25 cm in length). The test load was permitted to age at ambient conditions in the laboratory and a solid, granular reaction product was formed in the manner of Example 5. The granular explosive was placed in a 4 litre sheet metal container and positioned in a 1.8 m deep borehole and tampede with 1.35 m of sand. The charge was fired electrically using a shaped charge. Upon detonation, a crater 3 m in diameter was produced.

EXAMPLE 10:

Following the procedure of Example 5, a test load identical to the composition of Example 5 was prepared, aged, and solidified into granular form. The load was placed in an identical sheet metal container and aluminium foil wrapped around the side of the iron can. The borehole was loaded, tamped and fired in the manner of Example 5.

The resulting blast produced a crater 3.65 m in diameter, the improvement over the result of Example 9 being attributed solely to the presence of the aluminium foil. No residue of the foil was found, although torn pieces of the sheet metal can were found.

EXAMPLE 11:

Following the procedure of Example 10, the same explosive composition was prepared but instead of being permitted to react exothermally to form a granular reaction product, the liquid explosive composition was placed in the sheet metal can surrounded by the aluminium foil, in the manner of Example 10, and placed directly in the borehole. After thirty-five minutes time and while still in the fluid state, the test load was fired successfully using a shaped charge.

A crater 3.6 metres in diameter was produced.

EXAMPLE 12:

A self-spacing cavernous structure of aluminium and magnesium and 2.3 kg of TNT

were placed in a polyethylene bag and positioned in a 2 m deep borehole in the ground in the test area and tampede with one and one-half metres of sand. The test load was immediately fired electrically using a shaped charge.

A crater of the order shown hereinbefore was produced.

EXAMPLE 13:

Following the procedure of Example 12, 2.3 kg of TNT and an appropriate cavernous structure were placed in a polyethylene bag and the entire charge wrapped in aluminium foil. The load was positioned, tamped and detonated in the manner of Example 12.

The load was successfully detonated and produced a crater somewhat larger than that produced in Example 12.

EXAMPLE 14:

Following the procedure of Example 13, a 2.3 kg load of TNT and an appropriate cavernous structure was placed in a polyethylene bag, wrapped in aluminium foil as in Example 13, and a foil grid electromagnetic tamp made of aluminium and of the type illustrated in Figure 9 placed on the top of the charge. The resulting load was positioned, tamped and detonated in the manner of Examples 12 and 13.

The load was successfully detonated, producing a crater of a size similar to that of Example 13 but of greater depth.

WHAT WE CLAIM IS:—

1. An improved explosive charge comprising a cavernous structure of coarse, individual components of an electro-conducting material distributed throughout the charge in such a manner that the components are substantially in electrical contact throughout, a substantial proportion of the components being of such size that they are retained by a 20-mesh U.S. Standard sieve and of such an irregular shape that they form a system of cavities and channels which contain the explosive material.

2. An explosive charge in accordance with claim 1, characterized in that the electron-conducting material is a metal.

3. An explosive charge in accordance with claim 2, wherein the metal is a light metal.

4. An explosive charge in accordance with any one of claims 1, 2 or 3, characterized in that the individual components of electron-conducting material are elongated and at least 1 mm. and up to 6 mm. or more wide and up to 10 cm. or 15 cm. or more long.

5. An explosive charge in accordance with any one of claims 1 to 4, characterized in that the individual components of electron-conducting material have a circular, angular, curved, curled, and/or rolled configuration.

6. An explosive charge in accordance with any one of claims 1 to 5, characterized in that the explosive material is an ammonium nitrate explosive.

7. An explosive charge in accordance with claim 6, characterized in that the ammonium nitrate explosive has been introduced into the interstices, cavities and channels of the electron-conducting material, in the form of a liquid, preferably in the form of an aqueous, ammoniacal, or an aqueous ammoniacal ammonium nitrate solution and/or dispersion.

8. An explosive charge in accordance with any one of claims 1 to 7, characterized in that at least part of the electron-conducting material is in the form of circular componets.

9. An explosive charge in accordance with any one of claims 1 to 8, characterized in that the charge comprises, in addition, one or more tamps which are composed of one or more individual, preferably circular, plates or similar structures, at least one of which is in direct contact with the explosive material and/or the electron-conducting material, said tamps being of such material that they do not exert their effect by mechanical or structural strength.

10. An explosive charge in accordance with claim 9, characterized in that the plates making up the tamp consist of a light metal which exerts a directing effect on the blast by being part of the electron-conducting structure without having stability or mechanical strength high enough to produce the desired effect by mechanical or physical strength or by weight alone.

11. An explosive charge in accordance with claims 9 or 10, characterized in that the plate or plates of the tamp are perforated.

12. An explosive charge in accordance with any one of claims 1 to 11, characterized in that the charge contains, in addition, a sheath of an electron-conducting material, preferably of a light metal, which sheath preferably, does not exert its effect by mechanical or structural strength.

13. Process for the production of the explosive charge of claims 1 to 12, characterized in that the cavernous structure is formed in a suitable confining environment, such as a borehole or container, from the coarse, individual components of electron-conducting material, and preferably from a right metal, and the explosive is introduced in the form of a powder, granules, slurry or liquid into the interstices of the cavernous structure.

14. A method of blasting which comprises inserting an explosive charge in accordance with any one of claims 1 to 12, into a borehole or other cavity in the ground, covering the charge with a tamp, and exploding the charge by help of a suit-

able initiator.

15. A method in accordance with claim 14, characterized in that at least part of the inert tamp is replaced by an electromagnetic tamp which is composed of one or more individual, preferably circular plates or similar structures, at least one of which is close to or in direct contact with the explosive and/or the electron-conducting material forming the cavernous structure, said tamp being of such material that it does not exert its effect by mechanical or structural strength.

16. A method in accordance with claims 14 or 15, characterized in that the electromagnetic tamp is placed directly above the explosive charge.

17. A method in accordance with any one of claims 14 to 16, characterized in that the explosive charge is surrounded or wrapped in a sheath, such as a thin sheet or a foil of a light metal, which preferably does not exert its effect by mechanical or structural strength.

18. Process for the production of an explosive charge as claimed in claim 13, substantially as described with reference to the specific Examples.

19. An improved explosive charge whenever prepared by the process claimed in claims 13 or 18.

20. A method of blasting substantially as hereinbefore described with reference to Examples 1 to 7 and 9 to 14.

21. An explosive charge substantially as described and illustrated in the accompanying drawings.

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Fig.1.

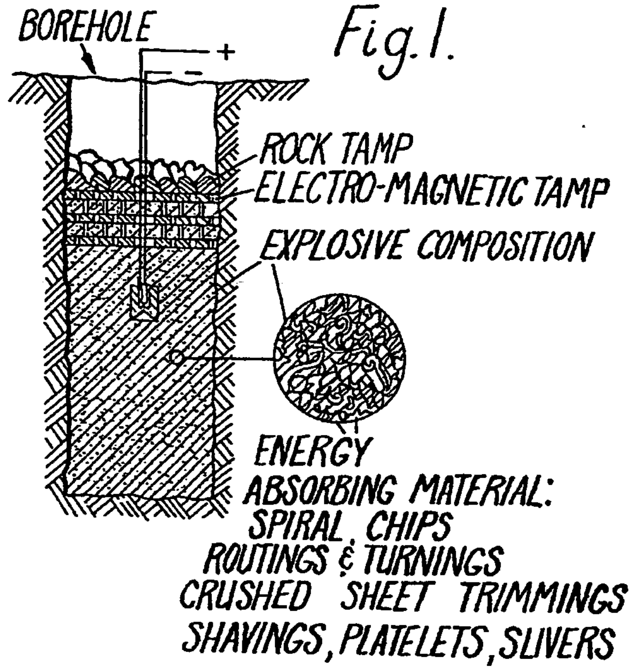


Fig.2.

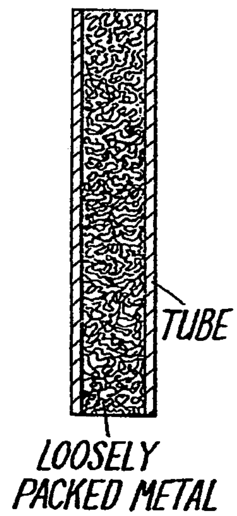


Fig.3.

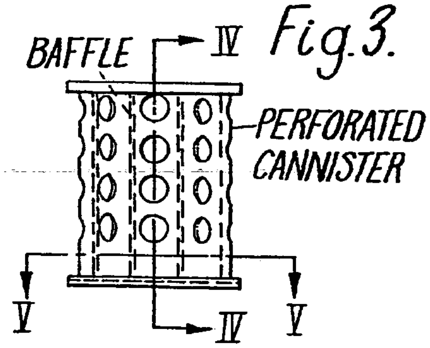


Fig.4.

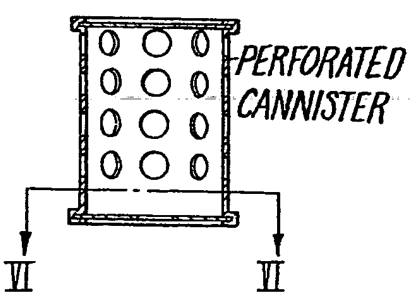


Fig.5.

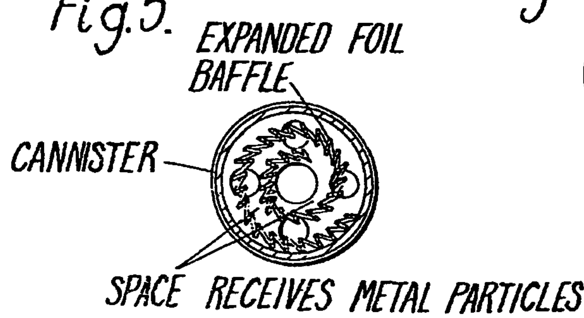
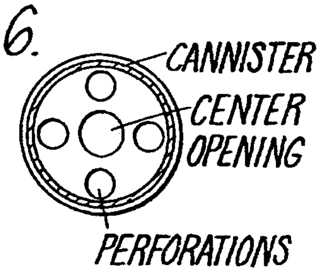


Fig.6.



951,620 COMPLETE SPECIFICATION

2 SHEETS

This drawing is a reproduction of the Original on a reduced scale.

SHEETS 1 & 2

Fig.8.

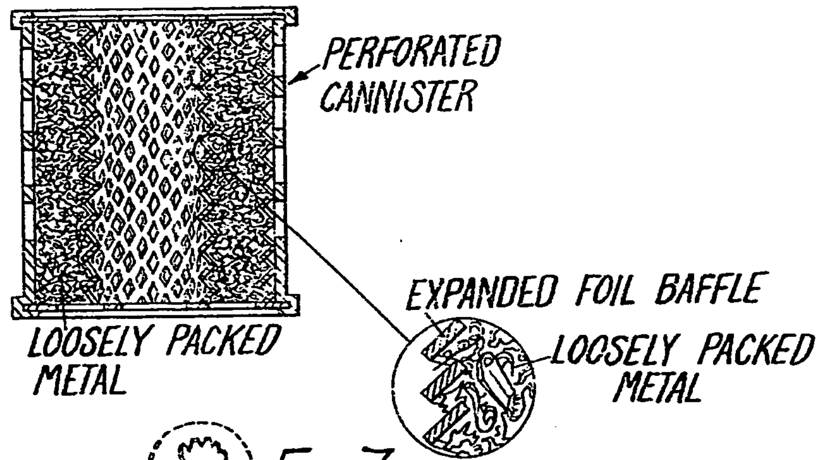


Fig.7.

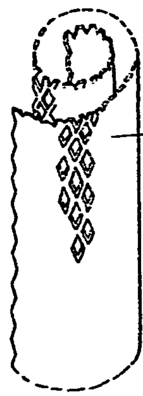


Fig.10.

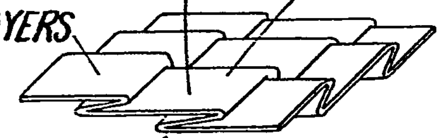
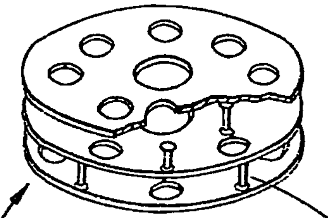


Fig.9.



951,620 COMPLETE SPECIFICATION
2 SHEETS This drawing is a reproduction of the Original on a reduced scale.
SHEETS 1 & 2

Fig.1.

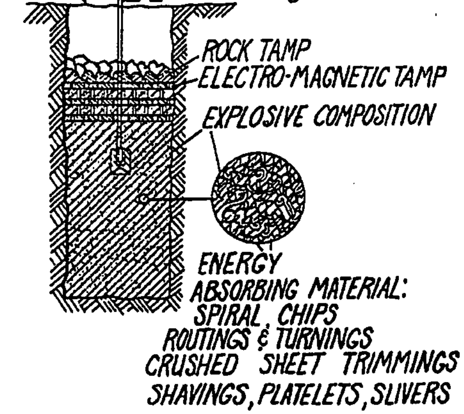


Fig.2.

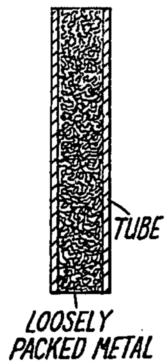


Fig.3.

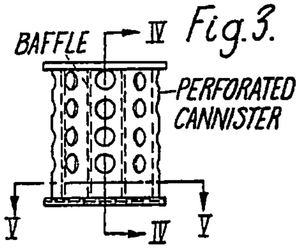


Fig.4.

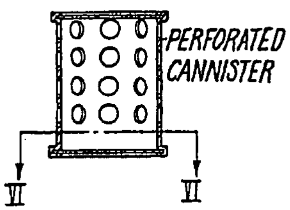


Fig.5.

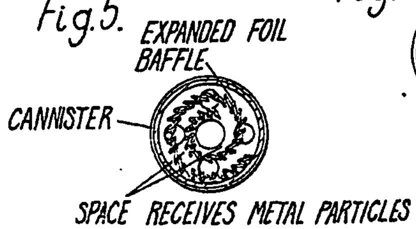


Fig.6.

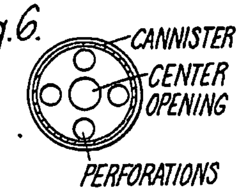


Fig.8.

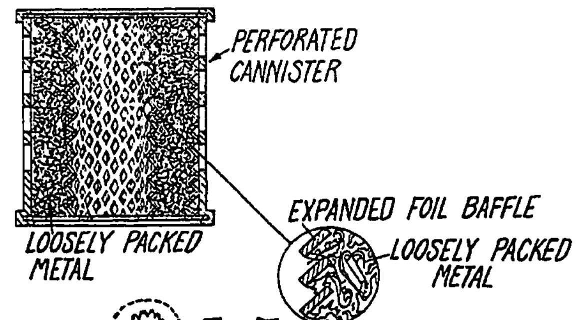


Fig.7.

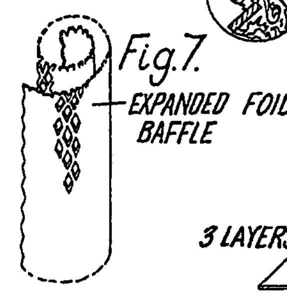


Fig.10.

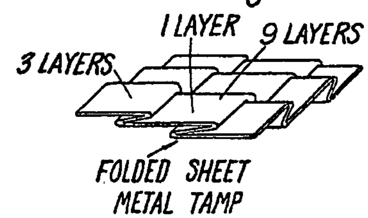


Fig.9.